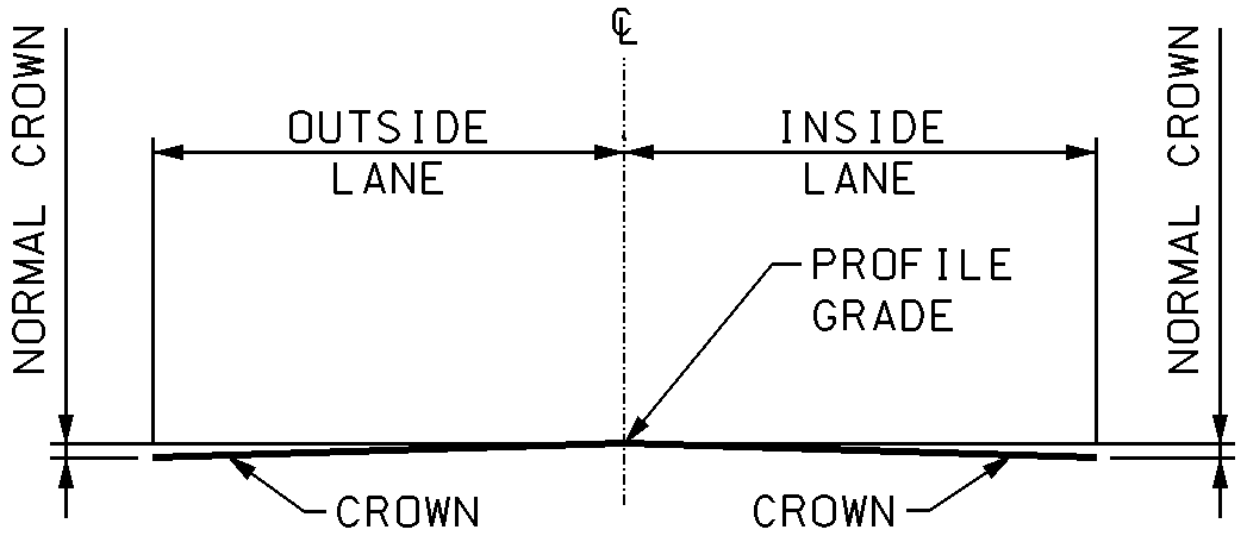
What is SuperElevation (SE)?

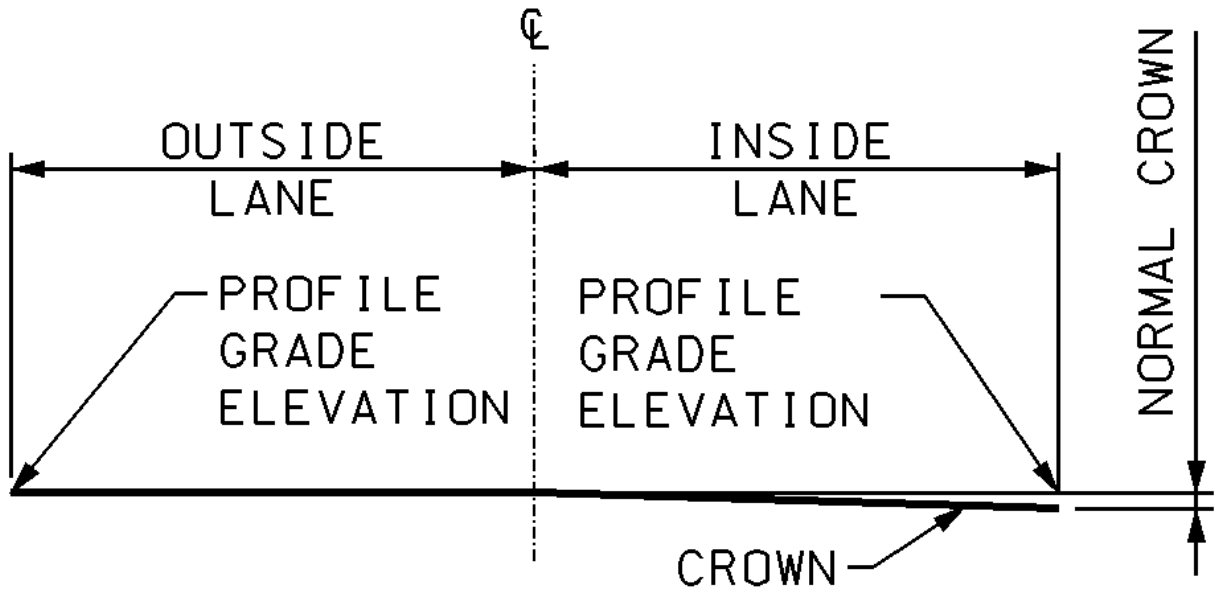
Superelevation is simply when we "tilt" a curve towards its inner side in order to keep vehicles from slipping due to the centrifugal forces acting upon them.

A super elevated section is proceeded by a transition section. The values of super elevation are determined from the AASHTO Design Guide and are a function of the rate of super elevation and the curve radius.

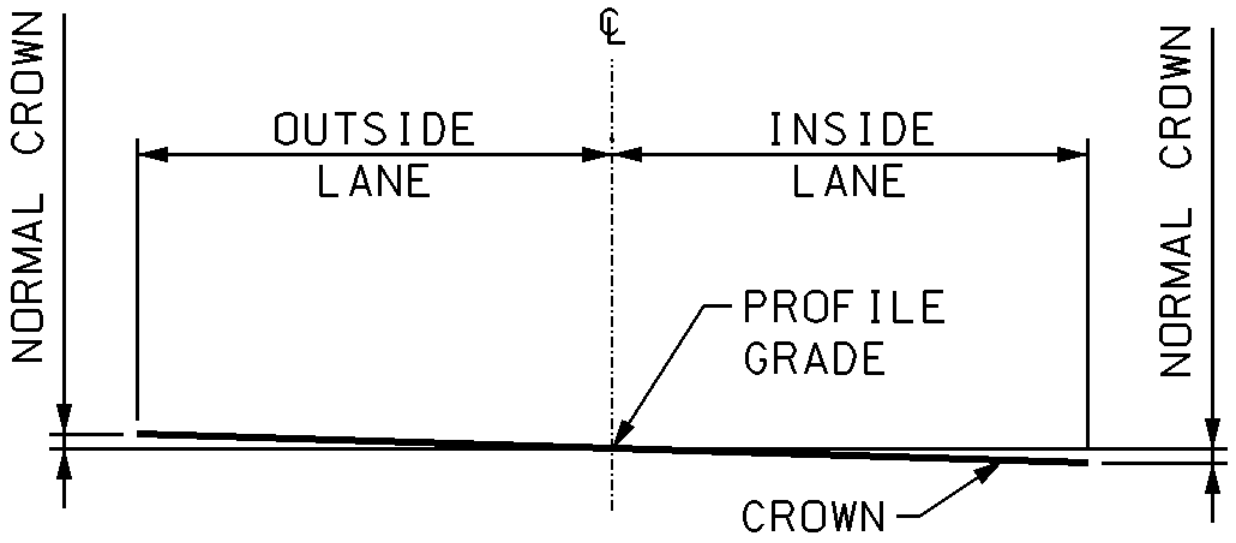
The superelevation transition sections included can also be at the following locations as described in the standard plans 203.20#, 203.21#, M203.20#, and M203.21# where # is the current standard revision: Section A-A (normal crown), Section B-B (0% superelevation), Section C-C (reverse crown), and Section D-D (full superelevation). Superelevation transition sections shall be perpendicular to the alignment they represent. The Designer including consultants shall provide all input files used to construct the superelevation shapes.



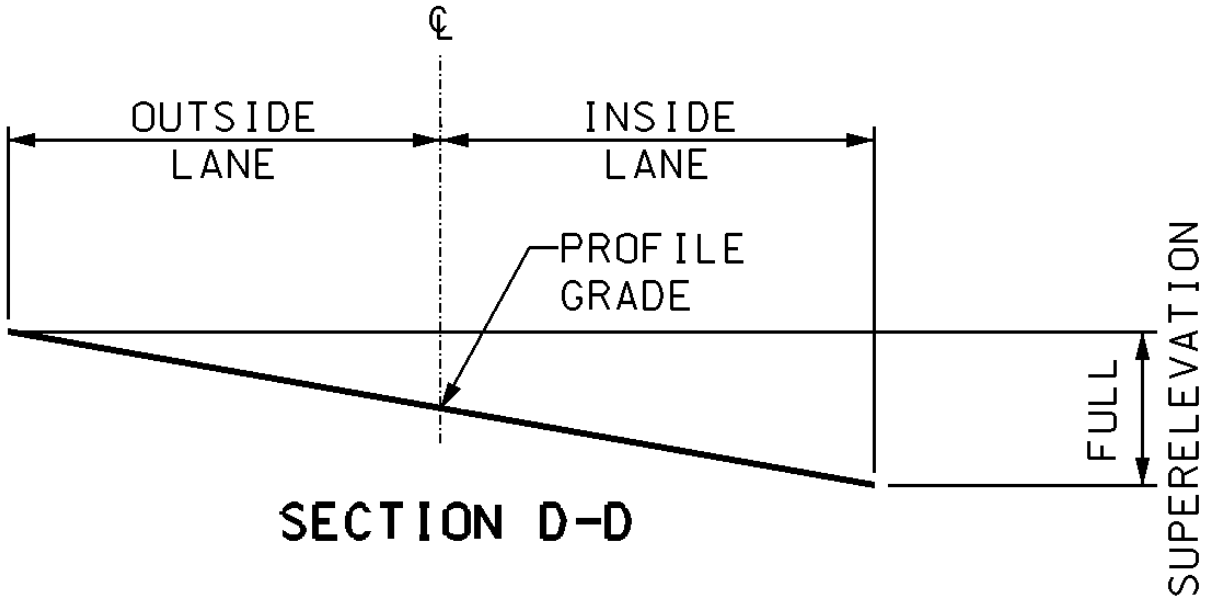
SECTION A-A



SECTION B-B



SECTION C-C


℄
OUTSIDE LANE
INSIDE LANE
PROFILE GRADE
FULL SUPERELEVATION
SECTION D-D

Reviewing the Auto Shape "SuperElevation" Input File

Upon computation of the superelevation parameters (cross slopes and stationing), the information is stored in an ASCII file, where the user may review and modify the transitions, if desired. After reviewing the information, the ASCII file is executed from the Autoshape Builder to generate superelevation shapes.

The Auto Shape Input File is an ASCII file specifying GEOPAK chains and superelevation transition breaks. Superelevation shapes created by Auto Shape contain elements concentric to the defined GEOPAK chains at specified offsets. These shapes also contain lines radial to the specified chains at superelevation transition breaks.

- The input file can be generated by GEOPAK during the automated superelevation procedure. However, the user may also type the ASCII file independent of any automated calculations.

One sample input file is illustrated. The input file is divided into several "auto shape sets." A new auto shape set must be established for each different shape cluster, every set of dependent shapes, every set of independent shapes, every unique set of GEOPAK chain and offset combinations and every unique parabolic transition option. For example, the first auto shape set contains only dependent shapes and since no transition id is specified, GEOPAK defaults to linear transition.

```
auto shape
job number = 92

auto shape set
shape cluster baseline = RAMPF
shape cluster profile = RAMPF
shape cluster tie = 0.00
dependent shape
chain / offset
RAMPF 0.00
RAMPF 15.00
filler line station / slope
732+39.95 -2.00
734+03.80 -2.00
736+53.80 -7.60
737+38.87 -7.60

auto shape set
independent shape
chain / offset
RAMPF 0.00
RAMPF -15.00
filler line station / slope
732+39.95 -2.00
734+03.80 -2.00
736+53.80 -7.60
737+38.87 -7.60

auto shape set
shape cluster baseline = CLCON
shape cluster profile = PRO
shape cluster pgl chain = RAMP
transition id = 2
dependent shape
chain / offset
RAMPG 0.00
RAMPG -15.00
filler line station / slope
34+03.80 -2.00
36+53.80 -5.60
37+38.87 -5.60
plot parameters
dependent shape
lv = 60
co = 15
dependent text
lv = 61
co = 1
independent shape
lv = 62
lc=3
independent text
lv = 63
wt=2
write shapes into dgn =rampf.dgn
```

The next auto shape set does not alter the shape cluster, it merely redefines the shape class from dependent to independent. The third auto shape set defines a new shape cluster with a pgl-chain and a transition id =2. Different transition id's may be utilized on the same alignment. If one transition type is to be used for an entire alignment, the type can be specified in the autoshape file, or in the cross section input file.

The number of individual shapes created is a function of the number of station/slope combinations defining filler lines. The number of created shapes is always one less than the number of specified filler lines. For example, consider the following input file fragment:

```
chain / offset
 AL20 -40.0
 AL20 -28.0
filler line station / slope
 570+00 r 3 -1.5
 575+45.29 r 3 -1.5
 577+50 r 3 -5.51
```

In this instance, two shapes are created. One shape would consist of a constant -1.5 slope between stations 570+00 and 575+45.29. The other shape would be a transition shape between 575+45.29 and 577+50. This shape would transition between a -1.5 slope at 575+45.29 and a -5.51 slope at station 577+50. In both instances, the longitudinal sides of the shapes would consist of a chain parallel to chain AL20 at an offset of 40.0 master units and a chain parallel to chain AL20 at an offset of 28.0 master units. The shapes also would contain lines radial to chain AL20 representing superelevation transition breaks. The first shape would contain a line radial to chain AL20 at stations 570+00 and 575+45.29. The second shape would contain a line radial to chain AL20 at stations 575+45.29 and 577+50. Note also that regions are specified. This is only necessary when the region is greater than one.

The improper identification of shape cluster elements or the improper classification of shapes as dependent or independent will result in incorrect proposed cross sections

The next grouping of optional lines are plot parameters for the shapes and associated text. The different parameters specified for dependent and independent shapes will be utilized by the software for the complex shape elements as well as the area fill. Parameters which can be specified include level, weight, line code, and color. Text parameters also include level, weight, line code, and color. Note that font, justification and text size are not user-definable as they are determined by GEOPAK. The text includes the slope labels on each end of the shape.

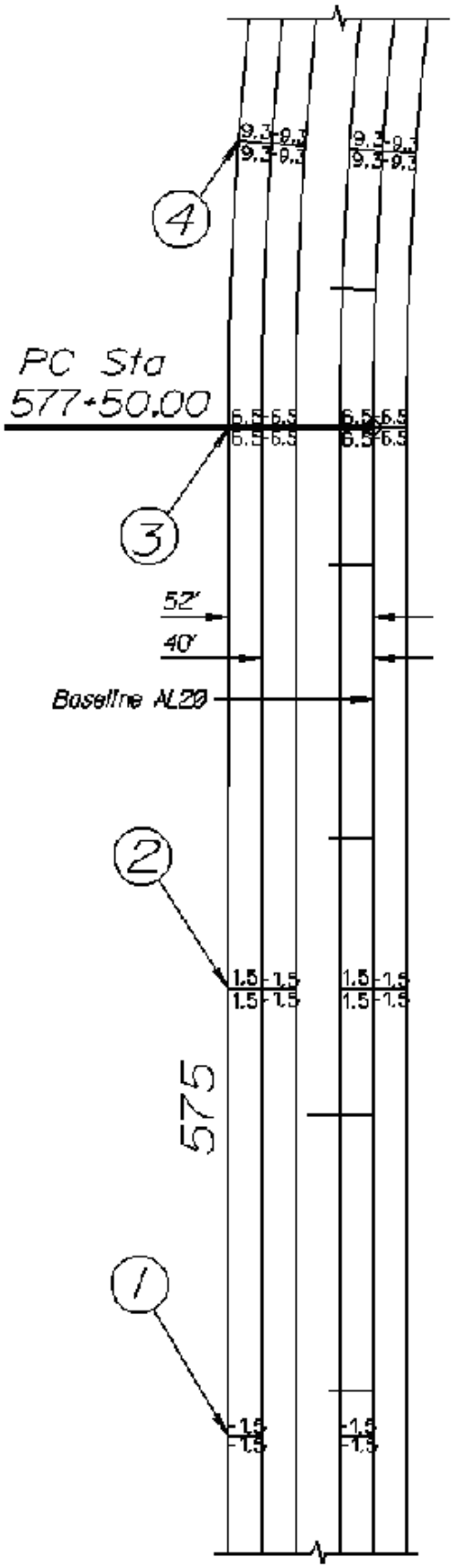
- If various text plot parameters are desired and the autoshape input file is generated via the GEOPAK automated superelevation processing, the text parameter lines must be manually added, as the automated processing does not include them.

The last line of the ASCII Auto Shape file dictates to the software the name of the MicroStation file where shapes are to be drawn. This graphical file will serve as input when generating proposed cross sections.

- If the input file is hand created or edited, special care must be given in the precision of the stations. An alignment with an ending station of 15+426.7745 should have stations entered with reasonable precision. A rounded station of 15+426.8 causes the shape to be created outside of the alignment.

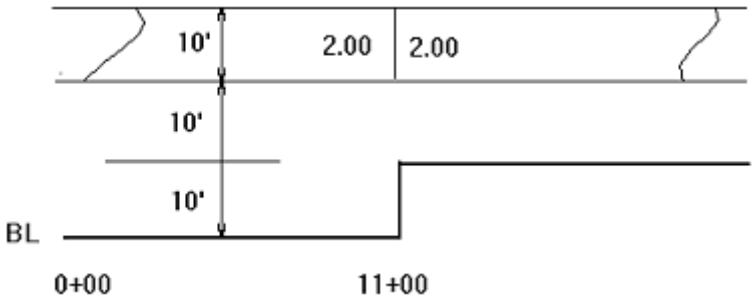
On the next page is an example of an auto shape file and accompanying graphical shapes. The sample is a multiple roadway utilizing a single alignment (al20) and profile (ptp19). The left-hand roadway consists of two lanes, one with offsets of -52 to -40 and the other with offsets of -40 to -28. These offsets are relative to the chain al20 with a tie of -40. The offsets -28 to -12 is not shaped as it is between roadways. The right hand roadway still utilizes al20 and ptp19, however, the tie is 0.0. The two lanes are from -12 to 0.0 and 12 to 0.0. Note the circled numbers on the illustration are denoted in the input file as (1), (2), etc.

```
auto shape
 job number = 001

auto shape set
 shape cluster baseline = al20
 shape cluster profile = ptp19
 shape cluster tie = -40.00
 dependent shape
 chain / offset
 al20 -40
 al20 -28.00
 filler line station / slope
    570+00 -1.5
 575+45.29 -1.5 (2)
    577+50 -6.5 (3)
    578+50 -9.3 (4)
    586+36 -9.3

auto shape set
 independent shape
 chain / offset
 AL20 -40.00
 AL20 -52.0
 filler line station / slope
   570+00 -1.5
   573+84 -1.5 (1)
 575+45.29 1.5 (2)
    577+50 6.5 (3)
    578+50 9.3 (4)
    586+36 9.3

 auto shape set
 shape cluster baseline = al20
 shape cluster profile = ptp19
 shape cluster tie = 0.0
 independent shape
 chain / offset
 al20 -12.0
 al20 0.0
 filler line station / slope
 .
 .
 auto shape set
 independent shape
 chain / offset
 al20 00.0
 al20 12.0
 filler line station / slope
 .
 .
write shapes into dgn = tsh.dgn
```



Autoshaping and Shifts

Autoshape sets cannot cross over a shift. Each autoshape set represents a continuous pavement surface offset from a PGL. A shift on the PGL within an autoshape set will cause the road surface to move with the shift, creating an abnormal pavement surface shape.

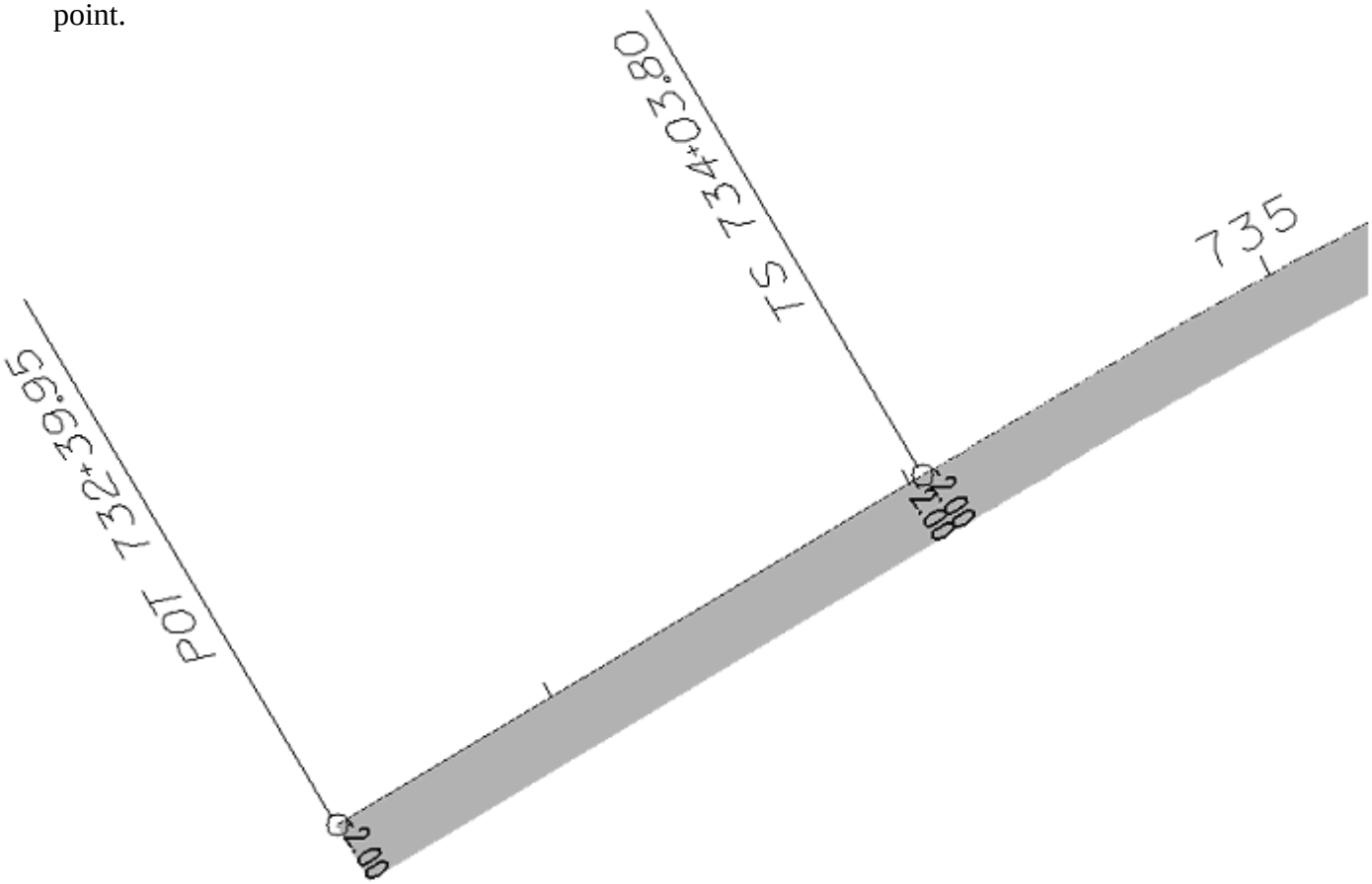


To create a continuous pavement surface offset from a PGL which contains a shift, use different autoshape sets before and after the shift. Note that the first station in the second autoshape set must come after the shift. If the design requires the second autoshape set to begin at the exact station of the shift, a station equation can be used at the shift to create two locations with the same stationing. Let's look at an example with a shift at 11+00.
The auto shape sets are shown below:

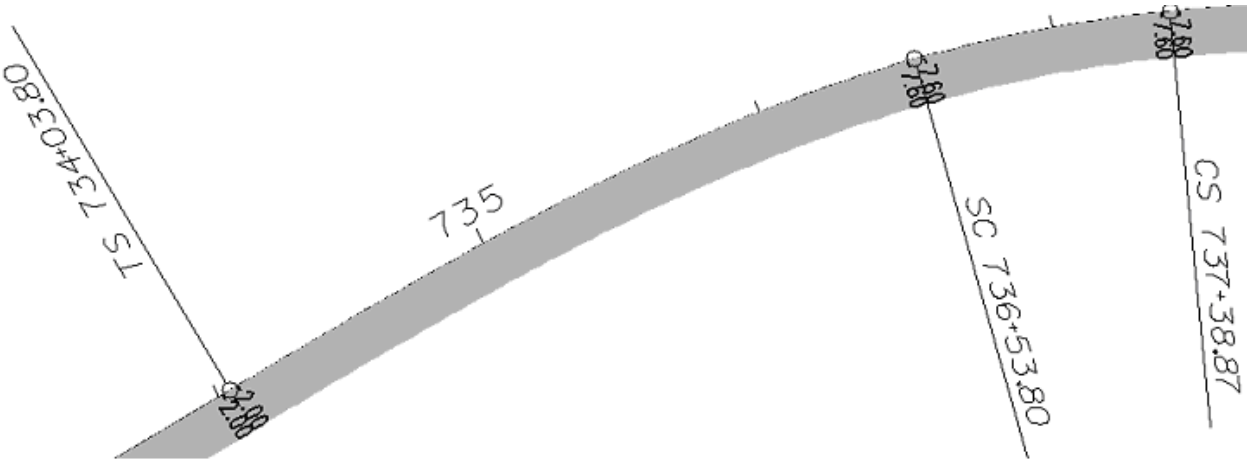
```
auto shape set
 shape cluster baseline = bl
 shape cluster profile = prof
 shape cluster tie = 0.0
 independent shape
 chain / offset
 BL -20.0
 BL -30.0
 filler line station / slope
 0+00.00 2.00
 11+00.00 2.00

auto shape set
 independent shape
 chain / offset
 BL -10.00
 BL -30.00
 filler line station / slope
 11+00.01 2.00
 20+00.00 2.00
write shapes into dgn = plan.dgn
```

Superelevation Shapes

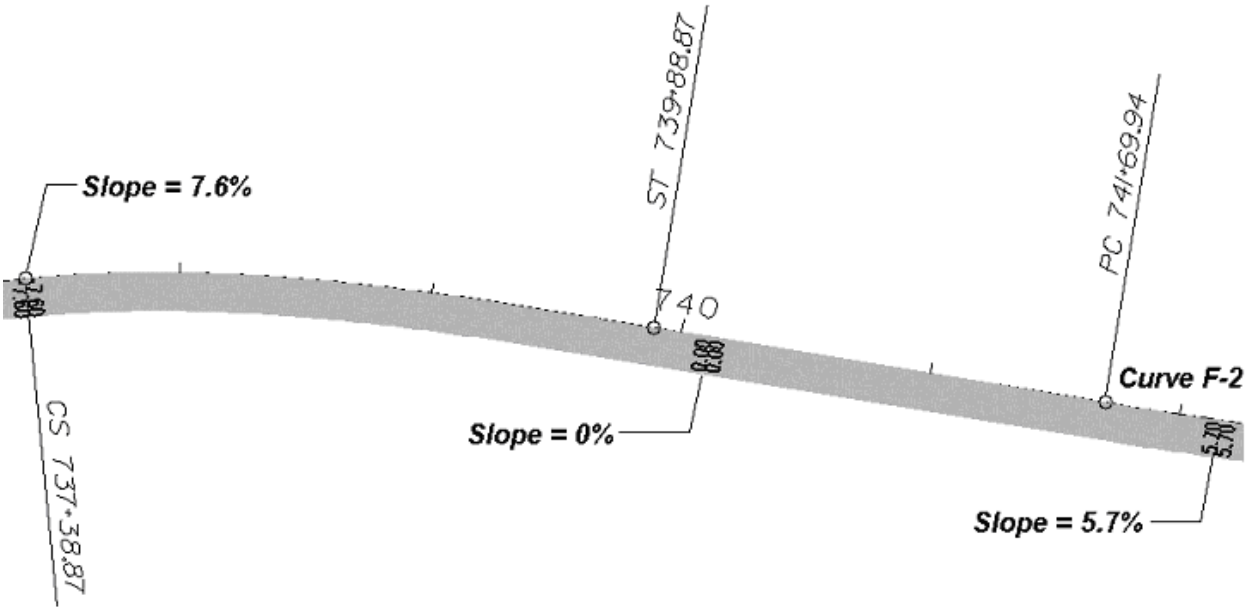
A review of the shapes generated from the Superelevation shape input file gives insight into how superelevation transitions are calculated. To begin with, GEOPAK holds the normal crown between station 732+39.95, the beginning of the chain, and station 734+03.80, the tangent spiral point.



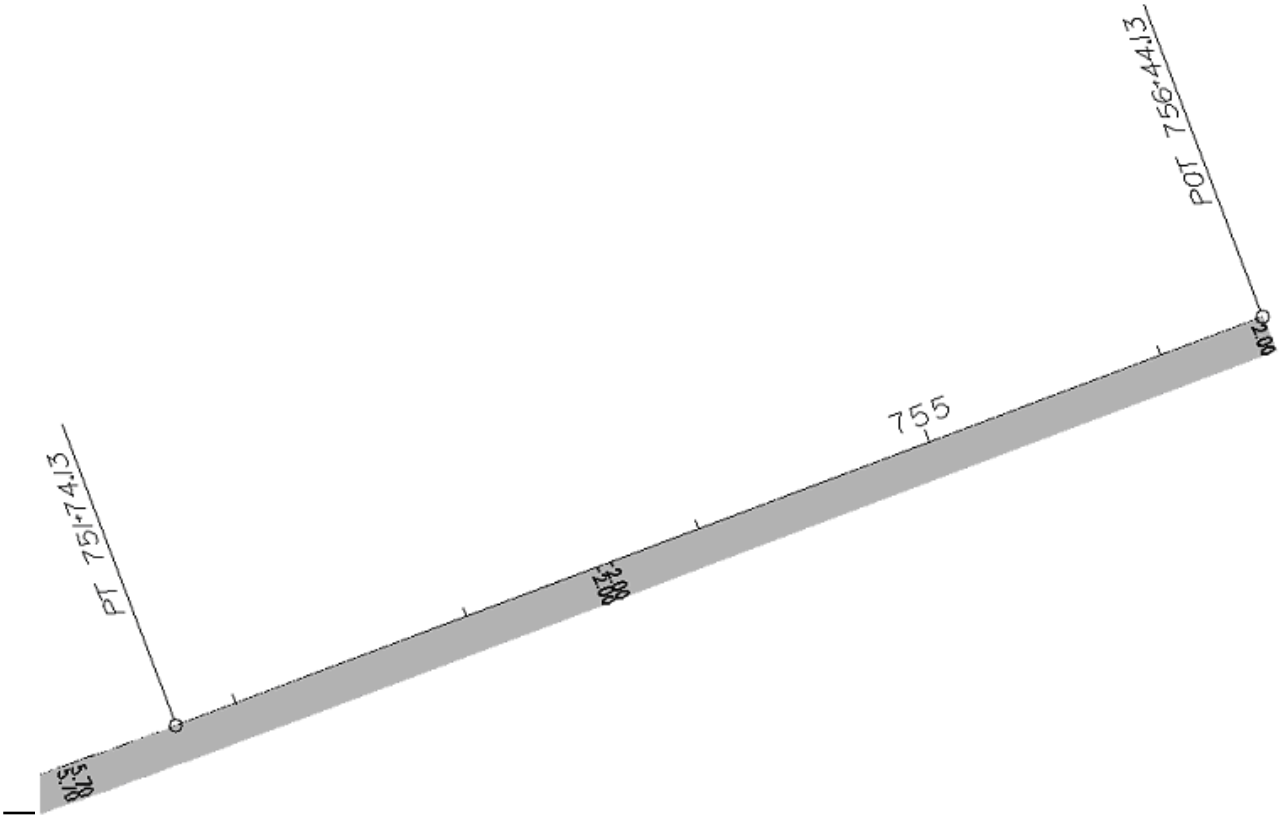
Along the spiral the slope transitions from the normal crown of 2% to the full super of 7.6% at station 736+53.80. The 7.6% slope is the rate of superelevation calculated by GEOPAK for Curve F-1 and a 30 mph design speed.



A short 180 foot tangent exists between the spiral-curve-spiral combination and the succeeding curve. This tangent is too short to transition the pavement to normal crown. Therefore, GEOPAK interpolates between the points of full super at stations 737+38.87 and 742+15.14 to determine a level station point (0.0%) at station 740+2.59. Incidentally, the control point for full superelevation on Curve F-2 (station 742+15.14) is set at a distance from the PC equal to a fraction of the length of runoff specified in the Superelevation Configuration tables. In addition, the 5.7% slope is the rate of superelevation calculated by GEOPAK for the 50 mph design speed specified for Curve F-2.



The remainder of the ramp transitions from the 5.7% slope on Curve F-2 back to normal crown.



Examples

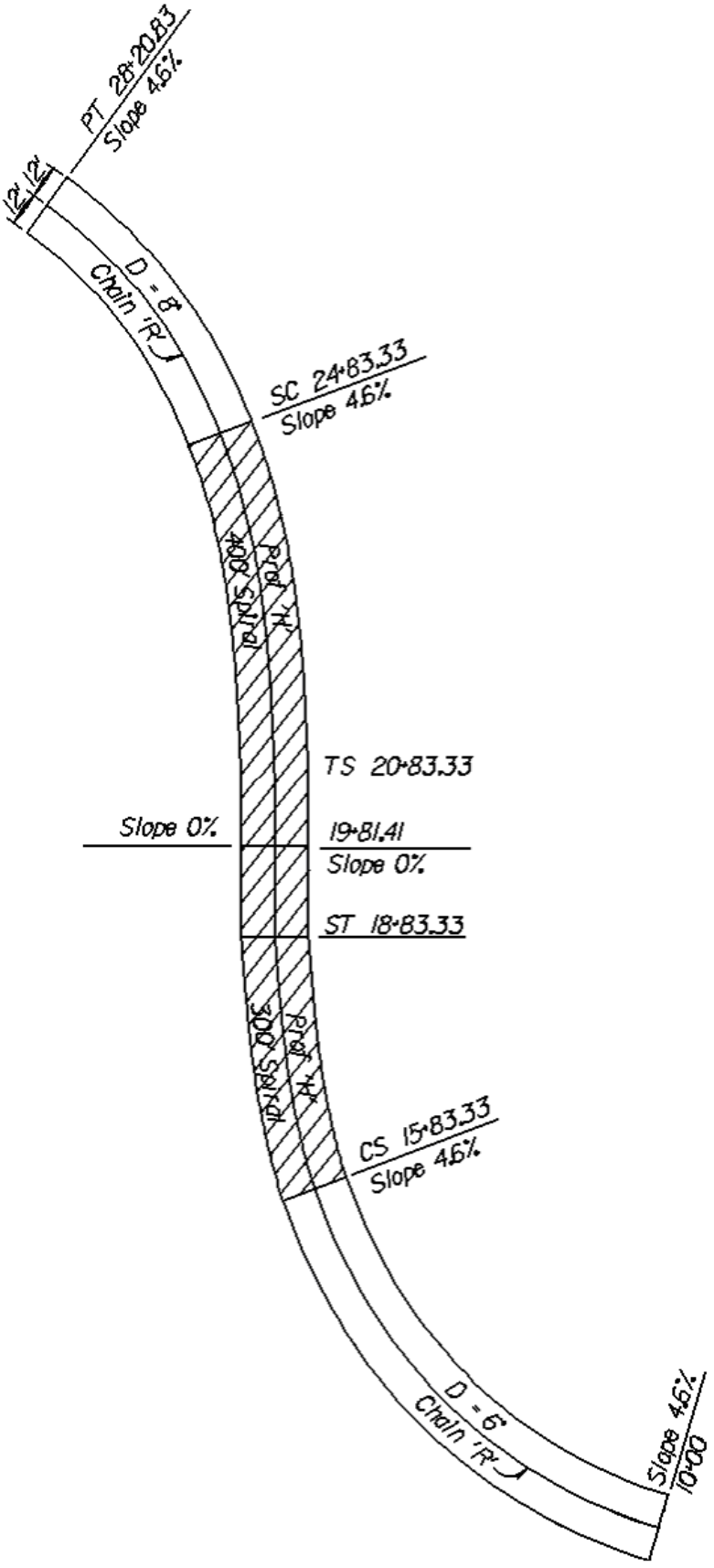
The following pages depict these three examples:

Example One

The first example is a basic two lane roadway demonstrating the basic superelevation calculations.

The resultant autoshape file is as follows:

```
auto shape
job number = 62
 auto shape set
 shape cluster baseline = R
 shape cluster profile = H
 shape cluster tie = 0.0
dependent shape
 chain / offset
 R -12
 R 0
 filler line station / slope
 10+00.00 4.60
 15+83.33 4.60
 19+81.41 0.00
 24+83.33 -4.60
 28+20.83 -4.60

auto shape set
 shape cluster baseline = R
 shape cluster profile = H
 shape cluster tie = 0.0
dependent shape
 chain / offset
 R 0
 R 12
filler line station / slope
 10+00 -4.60
 15+83.33 -4.60
 19+81.41 0.00
 24+83.33 4.60
 28+20.83 4.60

write shapes into dgn = cfile.dgn
```

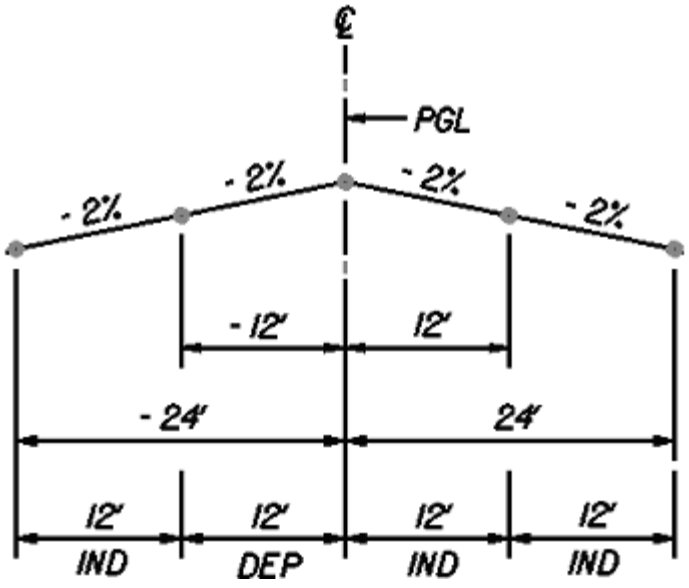


Example Two

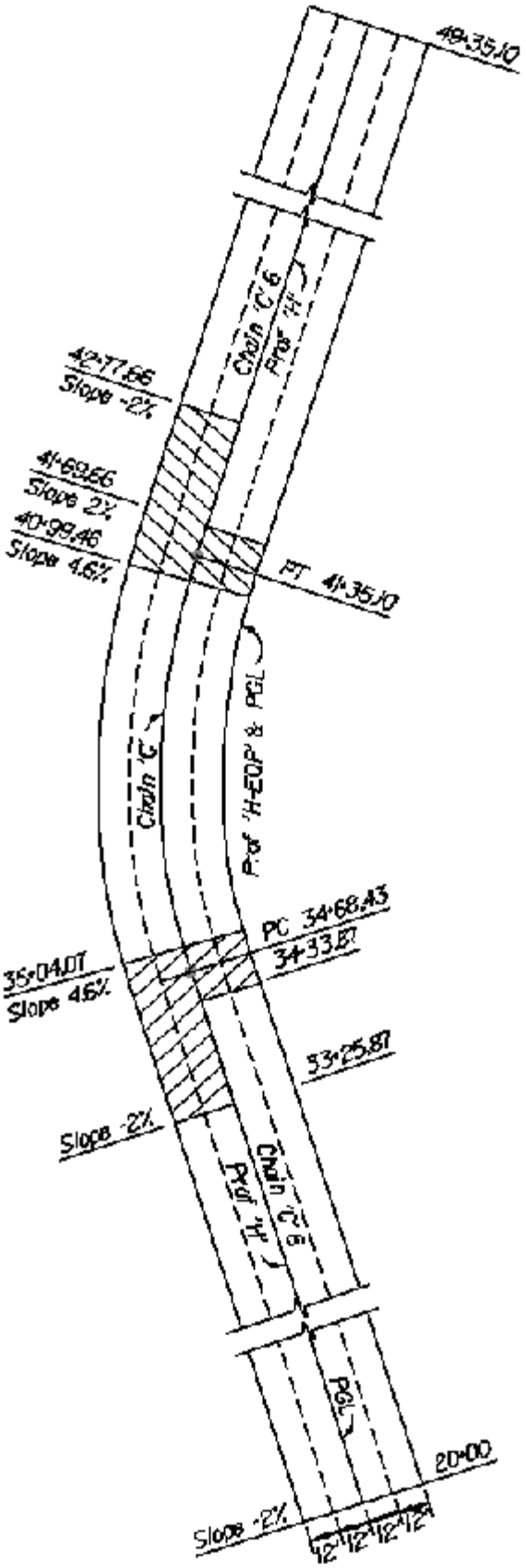
The next example is slightly more complicated, demonstrating a four lane roadway and the optional inside rotation.

The autoshape input file (mm1.inp) is as follows:

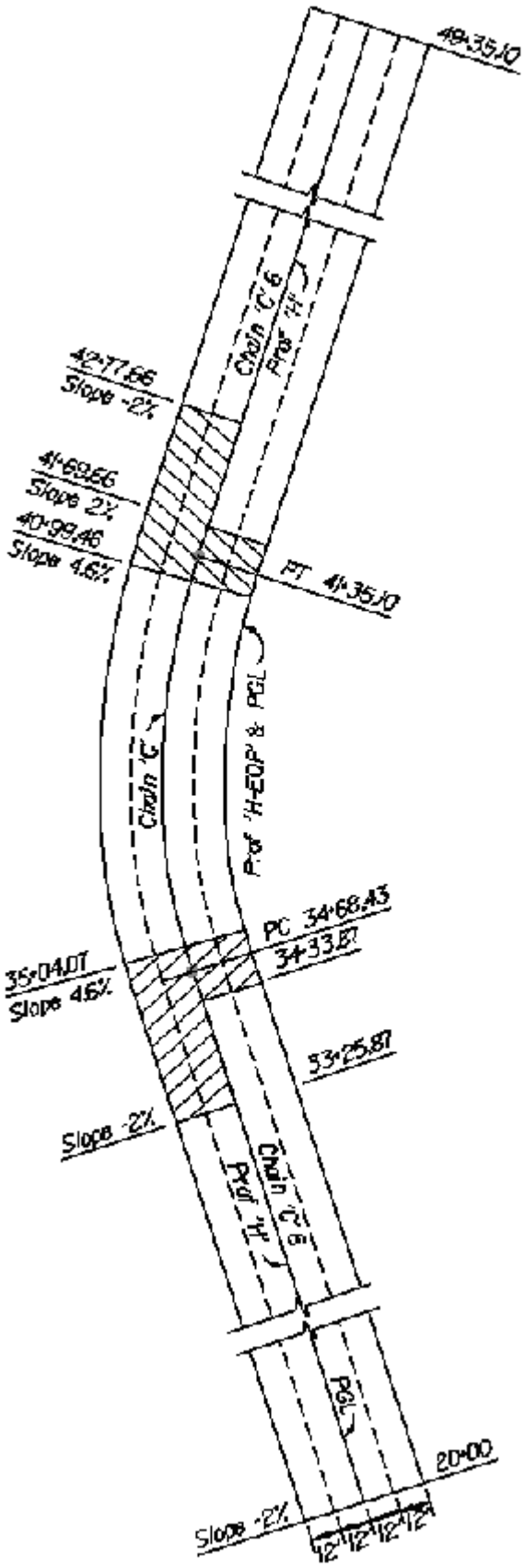
```
auto shape
job number = R
 auto shape set
 shape cluster baseline = C
 shape cluster profile = H
 shape cluster tie = 0.00
independent shape
chain / offset
 C -24.00
 C -12.00
filler line station / slope
 20+00.00 -2.00
 33+25.87 -2.00
 34+33.87 2.00

auto shape set
 shape cluster baseline = C
 shape cluster profile = H_EOP
 shape cluster tie = 24.00
independent shape
 chain / offset
 C -24.00
 C -12.00
filler line station / slope
 34+33.87 2.00
 35+04.07 4.60
 40+99.46 4.60
 41+69.66 2.00

auto shape set
 shape cluster baseline = C
 shape cluster profile = H
 shape cluster tie = 0.00
independent shape
 chain / offset
 C  -24.00
 C -12.00
filler line station / slope
 41+69.66 2.00
 42+77.66 -2.00
 49+35.10 -2.00
```



```
auto shape set
 shape cluster baseline = C
 shape cluster profile = H
 shape cluster tie = 0.00
independent shape
 chain / offset
 C -12.00
 C 0.00
filler line station / slope
 20+00.00 -2.00
 33+25.87 -2.00
 34+33.87 2.00

auto shape set
 shape cluster baseline = C
 shape cluster profile = H_EOP
 shape cluster tie = 24.00
independent shape
 chain / offset
 C -12.00
 C 0.00
filler line station / slope
 34+33.87 2.00
 35+04.07 4.60
 40+99.46 4.60
 41+69.66 2.00

auto shape set
 shape cluster baseline = C
 shape cluster profile = H
 shape cluster tie = 0.00
independent shape
 chain / offset
 C -12.00
 C 0.00
filler line station / slope
 41+69.66 2.00
 42+77.66 -2.00
 49+35.10 -2.00

auto shape set
 shape cluster baseline = C
 shape cluster profile = H
 shape cluster tie = 0.00
dependent shape
 chain / offset
 C 0.00
 C 12.00
filler line station / slope
 20+00.00 -2.00
 34+33.87 2.00

auto shape set
 shape cluster baseline = C
 shape cluster profile = H_EOP
 shape cluster tie = 24.00
independent shape
```

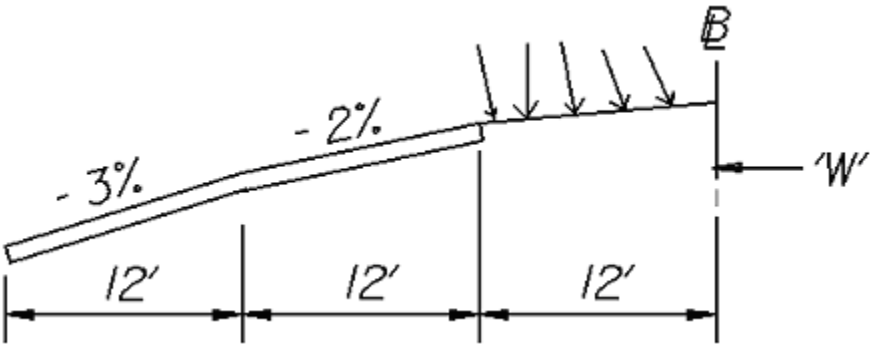


```
chain / offset
 C 0.00
 C 12.00
 filler line station / slope
 filler line station / slope
 34+33.87 2.00
 35+04.07 4.60
 40+99.46 4.60
 41+69.66 2.00

auto shape set
 shape cluster baseline = C
 shape cluster profile = H
 shape cluster tie = 0.00
 independent shape
 chain / offset
 C 0.00
 C 12.00
 filler line station / slope
 20+00.00 -2.00
 34+33.87 -2.00

auto shape set
 shape cluster baseline = C
 shape cluster profile = H
 shape cluster tie = 0.00
 independent shape
 chain / offset
 C 12.00
 C 24.00
 filler line station / slope
 20+00.00 -2.00
 34+33.87 -2.00

auto shape set
 shape cluster baseline = C
 shape cluster profile = H_EOP
 shape cluster tie = 24.00
 independent shape
 chain / offset
 C 12.00
 C 24.00
 filler line station / slope
 34+33.87 2.00
 35+04.07 4.60
 40+99.46 4.60
 41+69.66 2.00

auto shape set
 shape cluster baseline = C
 shape cluster profile = H
 shape cluster tie = 0.00
 independent shape
 chain / offset
 C 12.00
 C 24.00
 41+69.66 -2.00
 49+35.10 -2.00
write shapes into dgn mm1.dgn
```



Example Three

The third example utilizes a shape cluster with a negative tie and the addition of two lanes.



The resultant auto shape file is:

```
auto shape set
 shape cluster baseline = W
 shape cluster profile = W
 shape cluster tie = -12.000
 independent shape
 chain / offset
 W -35.00
 W -24.00
 filler line station / slope
 0+00.00 -3.00
 7+10.00 -3.00
 12.50.00 5.00
 20+84.50 5.00
 22+87.00 -3.00
 25+87.20 -3.00
 26+41.20 -5.00
 32+75.47 -5.00
 33+29.47 -3.00
 39+91.67 -3.00

auto shape set
 shape cluster baseline = W
 shape cluster profile = W
 shape cluster tie = -12.000
 dependent shape
 chain / offset
 W -12.00
 W -24.00
 filler line station / slope
 0+00.00 -2.00
 7+10.00 -2.00
 12.50.00 5.00
 20+84.50 5.00
 22+73.50 -2.00
 25+60.20 -2.00
 26+41.20 -5.00
 32+75.47 -5.00
 33+55.47 -2.00
 39+91.67 -2.00
write shapes into dgn = w-file.dgn
```

Super Elevation Exercise

```
/* Superelevation Settings and Parameters:

Project Name:  T:\de-proj\Cole\j5p0100\project\j5p0100.prj
User:          T:\de-proj\Cole\j5p0100\project\projdbs\userc
Run Name:      Bighorn
Unit System is english.
Created input file "shape-Bighorn.inp".
Created activity log file "shape-Bighorn.log".
Created on Wed, Oct 15, 2008 at 10:09.
Using Preference File "i_undivided"
Using e Selection of "8% max".
Using Length Selection of "all cases"
Using Design Speed of 45.000000.

*/

auto shape
job number = 100

   auto shape set
      shape cluster baseline   = BIGHORN
      shape cluster profile    = BIGHORNPR
      shape cluster tie        = 0.0000
      dependent shape
      chain  /  offset
         BIGHORN    -12.0000
         BIGHORN    0.0000
      filler line station / slope
          0+97.77     -2.0
          2+22.90     -2.0
          3+16.38     -6.2     /* Curve BIGHORN1 */
          3+76.72     -6.2     /* Curve BIGHORN1 */
          4+70.20     -2.0
          9+59.38     -2.0
         10+03.90      0.0
         11+41.90      6.2     /* Curve BIGHORN2 */
         13+15.02      6.2     /* Curve BIGHORN2 */
         14+53.02      0.0
         14+97.54     -2.0
         18+04.94     -2.0
         18+20.50     -2.7     /* Curve BIGHORN3 */
         18+45.50     -2.7     /* Curve BIGHORN3 */
         18+61.05     -2.0
         21+48.29     -2.0
```

Bighorn shape input file continues on next page:

```
   auto shape set
      shape cluster baseline   = BIGHORN
      shape cluster profile    = BIGHORNPR
      shape cluster tie        = 0.0000
      dependent shape
      chain  /  offset
         BIGHORN    0.0000
         BIGHORN    12.0000
      filler line station / slope
          0+97.77     -2.0
          1+33.86     -2.0
          1+78.38      0.0
          3+16.38      6.2        /* Curve BIGHORN1 */
          3+76.72      6.2        /* Curve BIGHORN1 */
          5+14.72      0.0
          5+59.24     -2.0
         10+48.42     -2.0
         11+41.90     -6.2        /* Curve BIGHORN2 */
         13+15.02     -6.2        /* Curve BIGHORN2 */
         14+08.50     -2.0
         17+16.05     -2.0
         17+60.50      0.0
         18+20.50      2.7        /* Curve BIGHORN3 */
         18+45.50      2.7        /* Curve BIGHORN3 */
         19+05.50      0.0
         19+49.95     -2.0
         21+48.29     -2.0

   Plot Parameters
      Dependent Shape
         lvname = Geopak-Shapes 1
         co = 6
         lc = 0
         wt = 2
      Dependent Text
      lvname = Geopak-Shapes 1
      co = 6
   Independent Shape
      lvname = Geopak-Shapes 1
      co = 1
      lc = 0
      wt = 2
   Independent Text
      lvname = Geopak-Shapes 1
      co = 1

Write shapes into dgn = T:\de-proj\Cole\j5p0100\data\bighorn_plan.dgn
```

Fill out Chart Below with all Critical Superelevation Transitions

Curve	Station	Section	Left Slope %	Right Slope %
BIGHORN1		A-A		
		B-B		
		D-D		
		D-D		
		B-B		
		A-A		

Curve	Station	Section	Left Slope %	Right Slope %
BIGHORN2		A-A		
		B-B		
		D-D		
		D-D		
		B-B		
		A-A		

Curve	Station	Section	Left Slope %	Right Slope %
BIGHORN3		A-A		
		B-B		
		D-D		
		D-D		
		B-B		
		A-A		

Exercise 1 Solution

Curve	Station	Section	Left Slope %	Right Slope %
BigHorn1	1+33.86	A-A	-2	-2
	1+78.38	B-B	-2	0
	3+16.38	D-D	-6.2	6.2
	3+76.72	D-D	-6.2	6.2
	5+14.72	B-B	-2	0
	5+59.24	A-A	-2	-2

Curve	Station	Section	Left Slope %	Right Slope %
BigHorn2	9+59.38	A-A	-2	-2
	10+03.90	B-B	0	-2
	11+41.90	D-D	6.2	-6.2
	13+15.02	D-D	6.2	-6.2
	14+53.02	B-B	0	-2
	14+97.54	A-A	-2	-2

Curve	Station	Section	Left Slope %	Right Slope %
BigHorn3	17+16.05	A-A	-2	-2
	17+60.50	B-B	-2	0
	18+20.50	D-D	-2.7	2.7
	18+45.50	D-D	-2.7	2.7
	19+05.50	B-B	-2	0
	19+49.95	A-A	-2	-2